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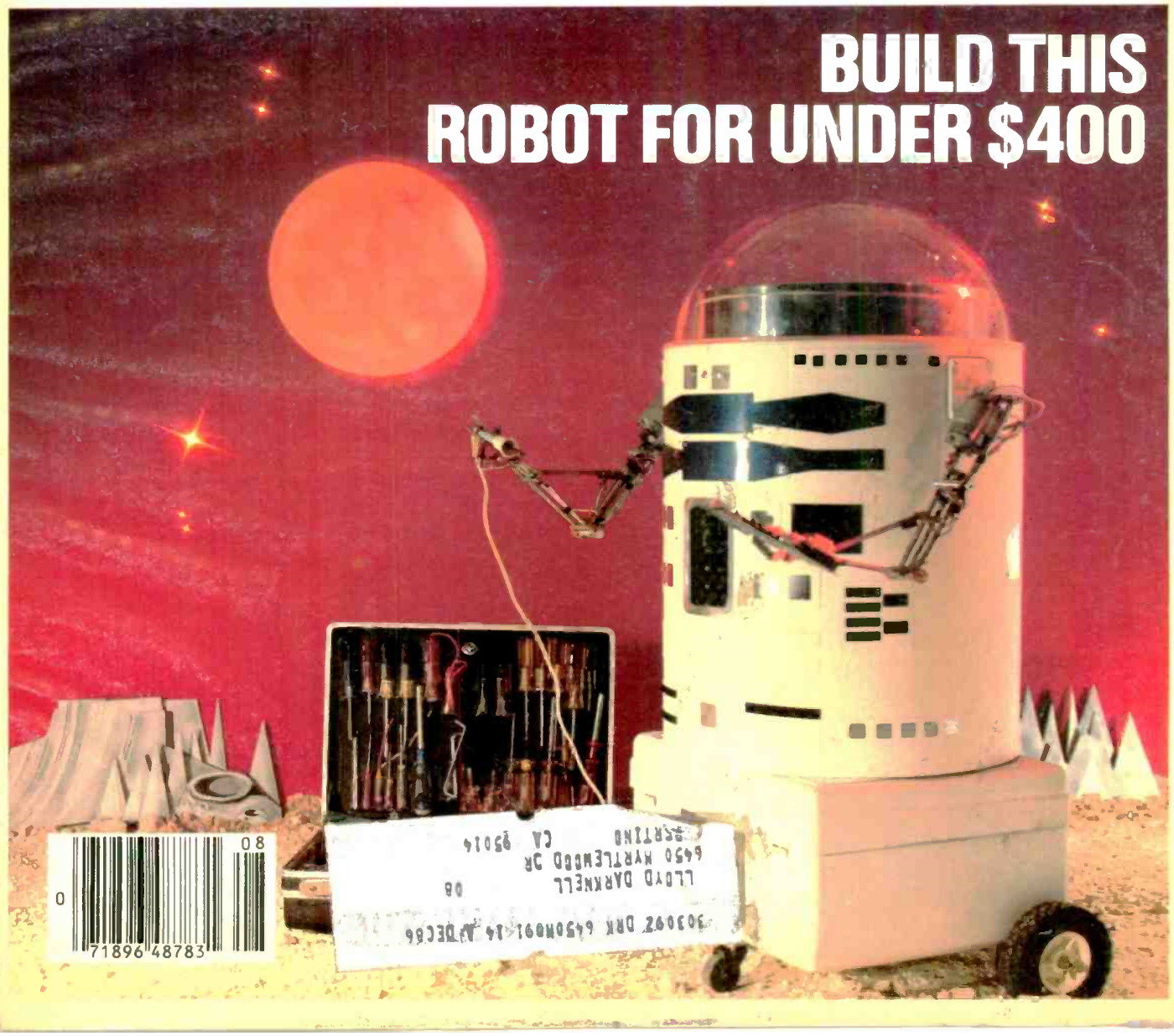

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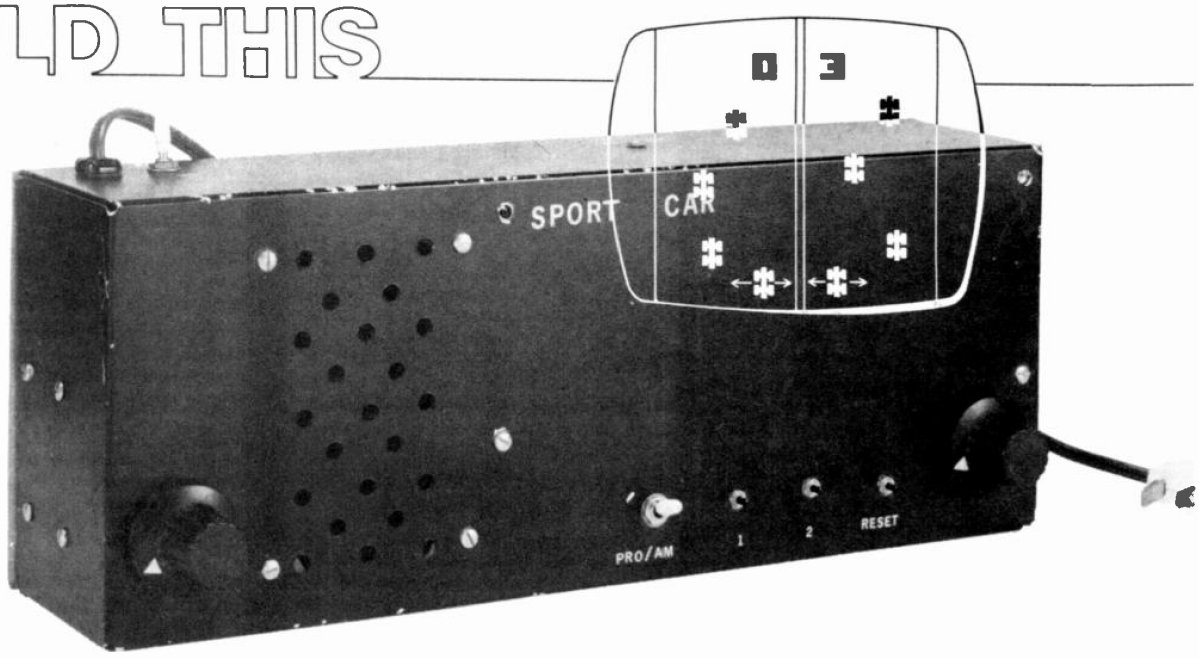


RACEWAY VIDEOGAME

Build this road-race game and enjoy all the excitement of the arcade version on your own video screen. Gentlemen (and ladies) . . . Start your engines!

L. STEVEN CHEAIRS

AMONG THE POPULAR ARCADE GAMES, THE road-race type has always stood out. Many varieties of that game exist; they range from the animated types to the more recent video units, of the type we're about to describe. There is a major difference between the game described here and the average Arcade road-race—the average Arcade game's price tag is in the thousands of dollars; while this game will cost you less than a hundred dollars.

In the pages of **Radio-Electronics** magazine we have presented two other video-game kits: a tank and a motorcycle game. The tank game (Nov. 1978) required two players; while the motorcycle game (Jan. 1979) was only for a single player. The present game allows both single- and dual-player operation. Thus, if you find yourself alone, or where no one else seems to want to play the game when you do, you can use the single game mode. But, when two or more players are available. . . .

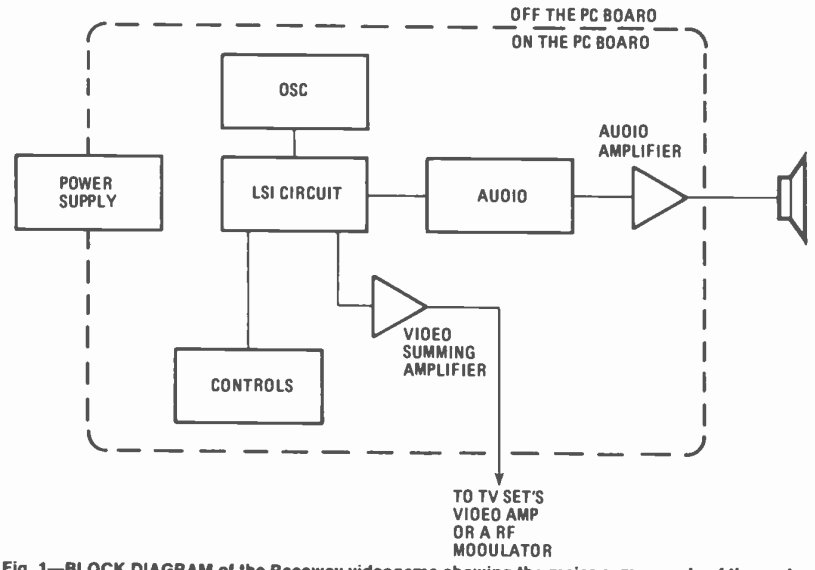


Fig. 1—BLOCK DIAGRAM of the Raceway videogame showing the major components of the system. Block labelled "Controls" is actually located off the board (controls are mounted on case).

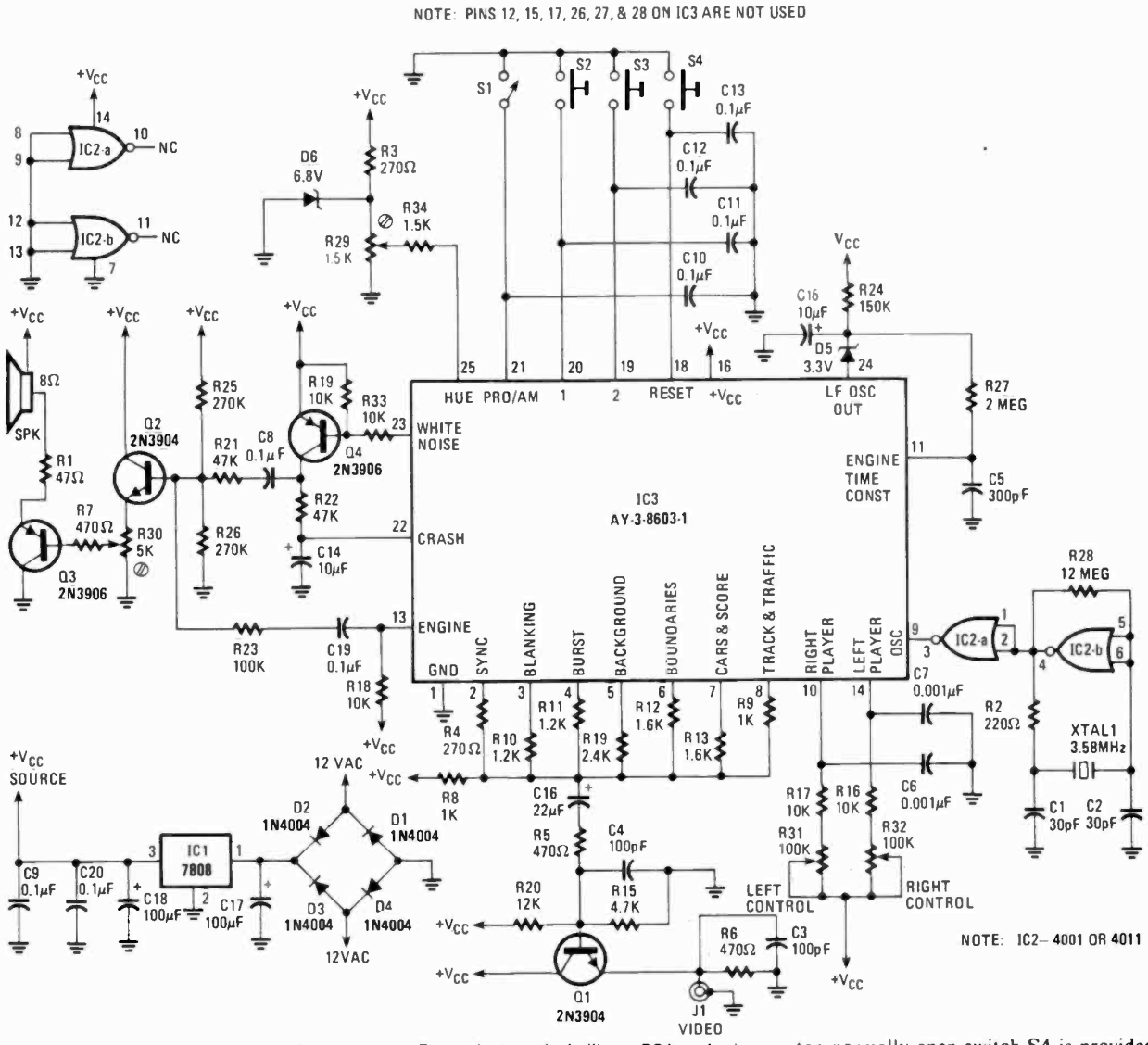


Fig. 2—COMPLETE SCHEMATIC of the Raceway game. The project may be built on a PC board using the foil pattern in Fig. 4 or wired point-to-point following this diagram.

System description.

The raceway game contains an assembled PC board and the switches, transformer, case and other hardware required for project assembly. Assuming that you wish to connect the system to a standard NTSC 525-line TV set, you will also need an RF modulator—many of which exist in the hobbyist's market.

The components contained on the printed-circuit board form seven distinct circuits. Two of those circuits contain components that are off the card; refer to the block diagram in Fig. 1 and the schematic in Fig. 2. The power supply provides 8 volts DC using a 12-volt AC, power source located off the board. The 12 volts AC is rectified by four silicon rectifiers and then filtered to reduce the 120-Hz ripple that is created by the full-wave bridge. A three-terminal linear regulator develops the operating voltage—additional filtering is provided at the regulator's output.

The control section is composed of two potentiometers, four switches, two R–C timing networks, and four capacitors. The potentiometers are used to vary the R–C time constant; that time constant is proportional to the position of the user's race car image on the TV screen. One or two race cars can be steered using these controls. Switch S1, labelled PRO/AM, is used to select the level of difficulty. Two normally-open switches are used for selecting the number of players (S2, labelled 1, selects the 1 player option; S3, labelled 2, selects 2 players.) The third push-button normally-open switch S4 is provided to reset the game. A minor amount of debounce is provided by the capacitor across the switch contacts.

The 3.579-MHz crystal oscillator is formed using a CMOS gate, two resistors, two capacitors and a crystal. Another CMOS gate is used as a buffer between the oscillator and the LSI integrated game circuit. Next, the audio amplifier and filtering circuit is formed using three transistors and a few capacitors and resistors.

The video summing circuit is of the passive-resistive type. The resistors R4, R9–R14 are chosen such to give a video signal with an appearance similiar to Fig. 3. The video signal out of the summing network is AC-coupled to the video amplifier Q1 which is wired as an emitter-follower. Note: if you use an RF modulator you may need to adjust the output

Fig. 3—COMPOSITE VIDEO SIGNAL typical of that produced by the summing network. It is a combination of raw video, sync and blanking signals generated by the IC. See text for explanation.

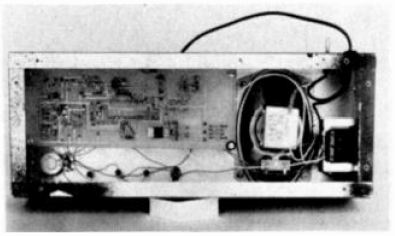
impedance of the amplifier. You do that by changing the emitter resistor. Normally, however, the adjustment will not be required. The final section is the LSI integrated circuit. That is a 28-pin DIP MOS IC that contains the game logic.

Construction

The raceway game may be assembled using either point-to-point wiring or wirewrap or a printed circuit board. Working from the schematic diagram shown in Fig. 2 any of those construction methods may be used. If you decide to build using the printed-circuit approach, then use the foil pattern shown in Fig. 4. Components are placed on the board as shown in Fig. 5. (An etched and drilled PC board is available—see the parts list.) Also, for those who do not have an adequate source of all the components, the source mentioned in the parts list will provide all of the hard-to-locate components on an individual basis or a complete kit that includes all electronic components, the PC board and the required hardware—including a blank unpunched case.

Assuming that you have chosen the PC board approach, start by laying all the electronic components out on a workbench. Make sure that the MOS and CMOS IC's remain in their conductive packages. Compare the components to the parts list to make sure you have everything you need. Mount the four corner spacers on the foil side of the printed circuit board with the hardware mentioned in the parts list; that way the spacers will act as table legs and raise the PC card off the work surface.

Install the two IC sockets in the proper location noting the proper orientation of pin 1 (see Fig. 5). Place a piece of cardboard on top of the sockets and by keeping a firm pressure on top of the cardboard and the PC board rotate them



COMPLETED UNIT. Components on bottom of board have been relocated in version described here.

upside-down so that the foil side is now up. Solder all of the pins using a 40-watt soldering iron with rosin-core solder. Replace the board with the component side up.

Install all of the resistors and capacitors. Verify their location and solder. Follow that step by installing the diodes, rectifiers, transistors, and voltage regulator; again, after placement and orientation, solder the components to the board. Lay the PC board aside until final assembly.

Locate the enclosure; drill the holes required for the potentiometers, switches, transformer attachment, PC-board attachment, speaker mounting, video output jack, and a line-cord strain-relief grommet. Next, paint the exterior of the case. After the paint is dry use dry-transfer lettering to label the controls. Follow that procedure by spraying the case with

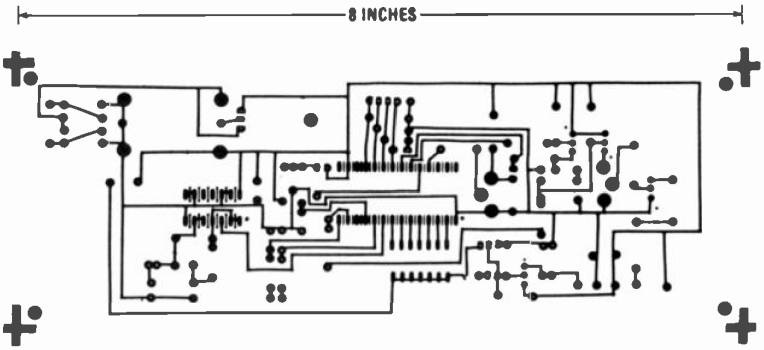


Fig. 4—FOIL PATTERN for the printed circuit board. For those who prefer not to etch their own, one is available from Quest-Star Electronics. See parts list for ordering information.

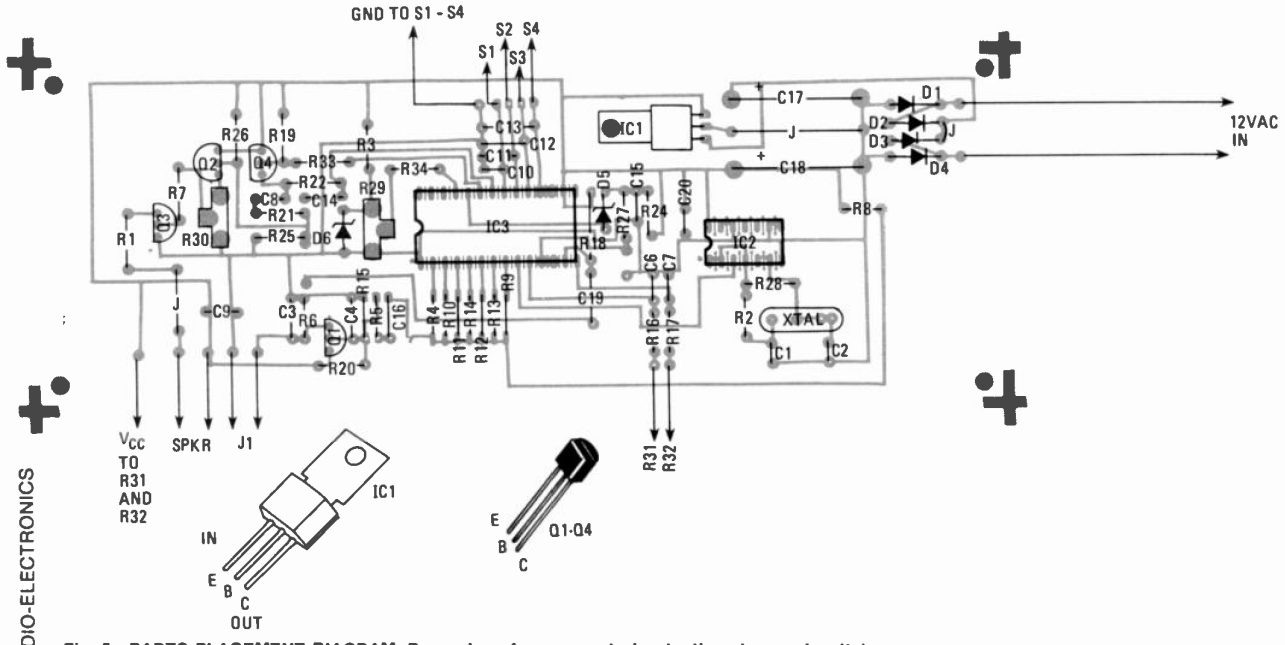
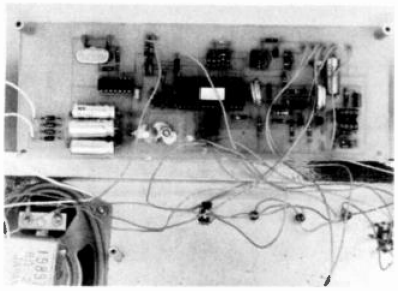


Fig. 5—PARTS PLACEMENT DIAGRAM. Power transformer, control potentiometers and switches, speaker and video jack are mounted off the board, on the case.



PC BOARD prototype.

PARTS LIST

Resistors ¼ watt, 5% unless otherwise noted
R1—47 ohms
R2—220 ohms
R3, R4—270 ohms
R5-R7—470 ohms
R8, R9—1000 ohms
R10, R11—1200 ohms
R12, R13—1600 ohms
R14—2400 ohms
R15—4700 ohms
R16-R19—10,000 ohms
R20—12,000 ohms
R21, R22—47,000 ohms
R23—100,000 ohms
R24—150,000 ohms
R25, R26—270,000 ohms
R27—2 megohms
R28—12 megohms
R29—1500 ohms, potentiometer, PC mount
R30—5000 ohms, potentiometer, PC mount
R31, R32—100,000 ohms, potentiometer
R33—10,000 ohms
R34—1500 ohms

Capacitors
C1, C2—30 pF
C3, C4—100 pF
C5—300 pF
C6, C7—.001μF
C8-C13—0.1 μF
C14, C15—10 μF, 15 volts, tantalum
C16—22 μF, 15 volts, tantalum
C17, C18—100 μF, 15 volts, electrolytic
C19, C20—0.1 μF

Semiconductors
D1-D4—1N4004
D5—1N746A Zener diode, 3.3 volts, 5%, 400 mW
D6—1N754A Zener diode, 6.8 volts, 5%, 400 mW
Q1, Q2—2N3904
Q3, Q4—2N3906
IC1—7808 voltage regulator, 3 terminals, 8 volts
IC2—4001 quad 2-input NOR gate or 4011 quad 2-input NAND gate
IC3-AY-3-8603-1 raceway game IC
S1—SPST miniature toggle switch
S2-S4—SPST normally open miniature push-button switch
SPKR1—small speaker, 8 ohms
J1—miniature phone jack
XTAL1—crystal, 3.58 MHz
Miscellaneous: knobs, line cord, 12-volt, 850 mA (or higher) transformer, case and hardware.
Note: The following may be ordered from Quest-Star Electronics, 5412 Burntwood Way, Las Vegas, NE 89108: Kit of all parts $59.95, AY-3-8603-1 game IC $27.00, PC board $12.95. Add $1.75 for shipping. Nevada residents add local taxes.

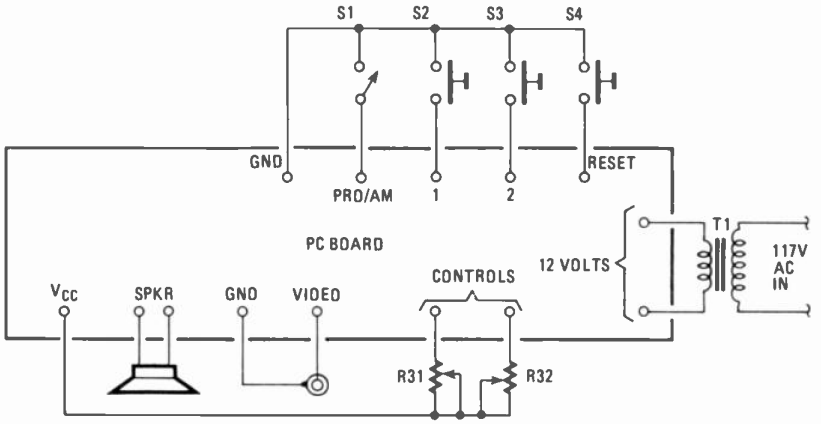


Fig. 6—DETAILS of off-the-board component connection. This should be used in conjunction with the parts placement diagram, Fig. 5. Also refer to photographs.

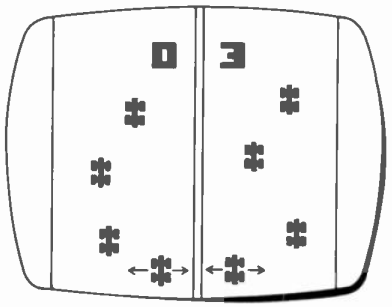


Fig. 7—RACEWAY VIDEOGAME display as it would appear on TV set or video monitor.

a clear lacquer paint to protect the finish—let the case dry for 12 to 24 hours.

Install the controls, transformer, linecord, output jack, and speaker. Wire those components as shown in Fig. 6. Recheck the wiring! Plug the line cord into a wall outlet and check to see if the proper DC voltage exists—around 8 volts. If so, discharge the filter capacitors and then install the IC's. Remove the spacers from the wiring side of the PC board and reinstall them on the component side of the board. Next, mount the PC board in the case. The assembly is now complete. Note: if an RF modulator is used it may be installed in the enclosure or inside of the TV cabinet. That is up to your discretion.

About the game

A typical game display consists of a two-lane highway with two player-controlled cars and randomly generated traffic. Each lane has a score at the top of the screen—see Fig. 7. The driver for each car is located at the bottom of each track. Adjust the TV contrast so the road is displayed as a white field; while the embankment, center line, player cars, and scores are gray. The traffic is displayed as black images. The car has horizontal motion only; that is a function of the potentiometer position. After the reset button is pressed the game starts. The TV screen shows the two tracks with the drivers' cars and the traffic. The scores are set to zero. Both tracks have the same set of random traffic. The traffic on the right is 24 horizontal scan lines ahead of the traffic on the left side of the screen. Thus, if the two-player game is selected, both players will encounter the same degree of difficulty.

The speed of the traffic in relation to the driver increases every two seconds, for up to a maximum of seven speeds, until one of the two players crashes his car into one of the obstacle cars. At that point all video motion stops and a crash sound is generated. The game again restarts in the slow motion and increases in speed every two seconds once more; during this time realistic engine sounds are simulated. The engine sound starts from a low and increases in pitch at four-second intervals during the periods when motion is observed on the screen. Every time a crash occurs, a point is scored for the opponent. The game ends when one of the players reaches 15 points.

The single-player game proceeds as outlined above, with the exception that only one of the player cars is present. The right car is removed—the left car is operatable. After every eight cars that the driver passes he scores a point; those must be consecutive passes. The occurrence of a collision resets the pass counter—thus those cars passed between the last score and the crash will not be counted toward a new point. The score above the right track records the number of crashes. Thus the user is playing against the machine, since the first score to reach 15 points wins the game.

As can be seen, a realistic raceway game may be produced for use with a standard television receiver fed through a video modulator. (Several suitable video modulators are available on the market. You can get them through **Radio-Electronics** advertisers and computer stores. If you have an option, select one with a UHF output.) This game provides realistic motor and crash sounds. Also, skill selection is provided for easy or difficult driving conditions. Scoring is automatic and on-screen; it is color-keyed for each player. Both one- and two-game selections exist; all the timing signals for

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RACEWAY
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black-and-white are provided.

Adjustment and troubleshooting.

There are two PC board potentiometers that require adjustment; the audio level and hue. The hue control (R29) is adjusted for the best contrast. The audio output (R30) should be adjusted to provide the desired noise level.

If problems occur after assembly use the following check list:

1. Are all components in the proper location?
2. Is PC board wired correctly to the external components?
3. Is the power supply voltage correct?
4. Is a 3.58-MHz clock signal present at pin 9 of the AY-3-8603-1?
5. Is there audio output?
6. Is there a composite video signal? (See Fig. 3 for waveform.)

If a "no" answer is generated by any of those questions then repair that portion of the circuit. For example, if a normal image is displayed, but the players' cars are not present; then check pin 7 to see if a video signal is present. If it is not, then the IC is bad; if a signal *is* present check the summing resistors. **R-E**